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THE INCUBATION PERIOD OF TYPHOID FEVER

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In most cases of typhoid fever the incubation period cannot be determined accurately, as the precise date of infection is unknown. There are, however, cases in the literature in which the time of infection is definitely known and in which, therefore, the distribution of the incubation period can be determined. Certain of these are treated in the present paper.

In an epidemic, described by Sawyer,[1] caused by the eating of infected spaghetti at a church dinner the distribution of the incubation periods of definite and of doubtful cases was as given in table 1:

The definite and doubtful cases do not therefore differ significantly in length of incubation period.

In an epidemic reported by Cumming,[2] due to the contamination of ice cream by a typhoid carrier, the distribution of incubation periods is given in table 2.

The mean of the fatal cases is 5.67 days, and the standard deviation is 0.471, while the mean of the nonfatal cases is 7.2 and the standard deviation is 1.887. By Pearson's goodness of fit test the probability that the fatal and nonfatal cases are random samples of the same population is 0.8. The difference in the means cannot, therefore, be considered significant on the basis of the present small numbers. The mean of the combined cases is 7 ± 0.26 days, and their standard deviation 1.84 ± 0.18 days.

Other cases due to infection of food have been reported by Schenck.[3] He reports nineteen cases with an incubation period of 12-16 days. Waterman[4] reports seventeen cases, 13-22 days. Pixley[5] reports two cases with an incubation period of 2 weeks; also 3 cases due to infected water with an incubation period of three weeks.

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[1] Jour. Am. Med. Assn., 1914, 73, p. 1537.

[2] Jour. Am. Med. Assn., 1917, 68, p. 1163.

[3] Jour. Am. Med. Assn., 1917, 69, p. 1402.

[4] Public Health, 1917, 5, p 157.

[5] N. Y. Med. Jour., 1913, 48, p. 328.

Laboratory infections are reported by Sawyer[6] (incubation period of 9 days), Hall[7] (21 days) and Boldman and Noble[8] (2 weeks).

In a water-borne epidemic at Mankato, Minn., reported by Hill,[9] there were 21 cases in which the patient had been in the city only one day and in which the incubation period was therefore definitely known.

We may similarly test whether male and female distributions differ significantly, the probabilities in this case that the distributions are random samples of the same population being 0.57. We cannot, therefore, conclude from this material that there is a significant difference in incubation period between males and females, although the fact that 10 patients who had been in the city for from 2 to 4 days showed the same tendency for females to have a longer incubation period strengthens the probability of its significance. The question deserves further investigation.

TABLE 1

NUMBER OF CASES OF TYPHOID CAUSED BY INFECTED SPAGHETTI SERVED AT CHURCH DINNER

Days	Definite	Doubtful	Total
3	1	.	1
4	3	1	4
5	12	.	12
6	19	.	19
7	13	.	13
8	7	3	10
9	2	3	5
10	2	.	2
11	5	.	5
12	2	.	2
13	.	1	1
14	2	.	2
15	3	.	3
16	2	.	–
17	1	.	1
18	1	.	1
19	2	1	3
20	.	.	.
21	2	.	2
22	.	.	.
23	1	.	1
24	1	.	1
25	1	.	1
26	1	.	1
27	.	.	.
28	.	.	.
29	1	.	1
	84	9	93

	Mean	Standard Deviation
Definite	9.52 ± .43	5.82 ± .30
Doubtful	9.67	3.94
Total	9.54 ± .39	5.63 ± .28

Jour. Am. Med. Assn., 1915, 64, p. 2053.

Buffalo Med. Jour., 1918-1919, 74, p. 12.

[8] N. Y. Med. Jour., 1911, 94, p. 1313.

[9] Jour. Infect. Dis.. 1911, 9, p. 410.

TABLE 2

INCUBATION PERIODS IN EPIDEMIC OF TYPHOID CAUSED BY INFECTED ICE CREAM

Days	Number of Cases		Total
	Fatal	Nonfatal	
5	1	3	4
6	2	5	7
7	.	7	7
8	.	1	1
9	.	1	1
10	.	1	1
11	.	1	1
12	.	1	1
	3	20	23

TABLE 3

WATER-BORNE EPIDEMIC OF TYPHOID AT MANKATO, MINN.

Days	Number of Cases		Total
	Male	Female	
5	1	1	2
6	.	.	.
7	1	.	1
8	2	.	2
9	.	.	.
10	1	1	2
11	.	1	1
12	1	.	1
13	.	.	.
14	.	1	1
15	1	1	2
16	.	1	1
17	3	.	3
18	1	2	3
19	.	.	.
20	1	.	1
21	.	.	.
28	.	.	.
29	.	1	1
	12	9	21

	Male	Female	Total
Mean	12.83	15.11	13.81 ± .83
Standard deviation	4.88	6.30	5.65 ± .59

TABLE 4

DISTRIBUTION OF INCUBATION PERIODS OF TYPHOID EPIDEMIC CAUSED BY WATER ON AN EXCURSION STEAMER

Days	Number of Cases	Days	Number of Cases
7	1	19	.
8	.	20	2
11	.	21	.
12	1	25	.
13	.	26	1
14	2	27	.
15	2	36	.
16	1	37	1
17	.	38	1
18	1	..	.
	8		5
		13	

In an epidemic reported by Lumsden,[10] caused by contaminated water on an excursion steamer, the distribution of incubation periods was as given in table 4:

The mean incubation period was 19.38 ± 1.66; the standard deviation was 8.85 ± 1.17.

In an epidemic reported by Ferguson,[11] caused by the contamination of the water supply at the Old Salem Chautauqua by a flood 4 days before the close of the Chautauqua, and in which, therefore, the incubation period is known within 4 days, the distribution including only certainly primary cases, is as given in table 5.

TABLE 5

DISTRIBUTION OF INCUBATION PERIODS IN EPIDEMIC AT THE OLD SALEM CHAUTAUQUA

Days	Cases	Days	Cases
7-10	1	23-26	9
8-11	2	24-27	3
9-12	3	25-28	3
10-13	6	26-29	3
11-14	16	27-30	2
12-15	6	28-31	3
13-16	10	29-32	2
14-17	10	30-33	2
15-18	16	31-34	1
16-19	18	32-35	1
17-20	9	33-36	4
18-21	10	34-37	1
19-22	11	35-38	.
20-23	7	36-39	1
21-24	10	37-40	1
22-25	10	.....	.
	145		36

$$\underbrace{145 \qquad\qquad 36}_{181}$$

Assuming that the infections occurred at the middle of the 4-day period of exposure, the mean incubation period is 19.50 ± 0.31 days and the standard deviation 6.10 ± 0.21. The moments about the mean are:

$$\pi_2 = 37.249;\quad \pi_3 = 183.812;\quad \pi_4 = 4708.17.$$
$$\beta_1 = .6538;\quad \beta_2 = 3.393.$$

The frequency curve representing the distribution of incubation periods is therefore Pearson's Type I. Working out the constants we find for its equation:

$$y = 12.396\left(1 + \frac{x}{5.955}\right)^{.8573}\left(1 - \frac{x}{40.040}\right)^{5.7641}$$

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[10] Pub. Health Repts., No. 104.

[11] Ill. Med. Jour. 1916, 30, p. 247.

The mode is at 15.55 ± 0.96 days; the skewness is + 0.65 = 0.14. This high positive skewness is also apparent in the other epidemics so far as the smallness of the numbers involved permits judgment as to the form of the distribution. It is, therefore, probably a general characteristic of the incubation period in typhoid fever, and renders more probable the isolated long incubation periods which are sometimes recorded and which might otherwise be attributed to a later unrecognized exposure. The lower limit of the curve is 9.59 days, the upper limit 55.59 days.

The curve, shown in chart 1, is evidently a good representation of the original data. By Pearson's test of goodness of fit the probability that divergences due to random sampling shall give a worse fit P = 0.49, i. e., in one-half the cases a sample would diverge from the population more than the present data do from the fitted curve. As the standard deviation is not abnormally high, the uncertainty as to incubation period has probably not affected the distribution appreciably.

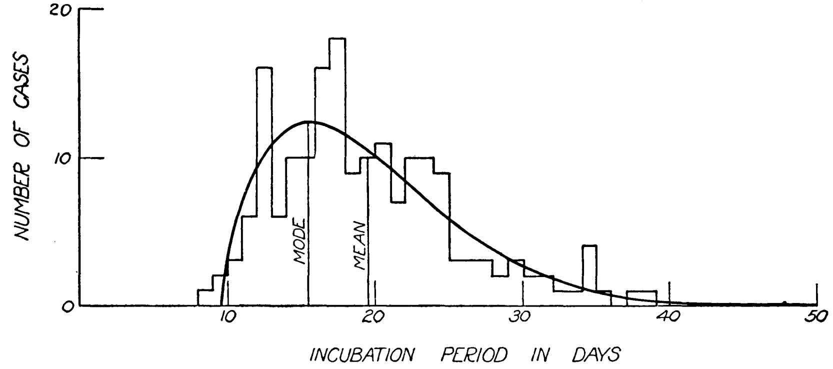

Chart 1.—Histogram and fitted curve for distribution of incubation period of typhoid.

SUMMARY

The incubation period of typhoid fever is highly variable, ranging in the cases here recorded from 3 to 38 or 40 days. The mean incubation period in different epidemics ranges from 7 ± 0.26 to 19.50 ± 0.31 days, differing significantly from one epidemic to another. The standard deviations range from 1.84 ± 0.18 to 8.85 ± 1.17. The distributions are positively skew.

The results here obtained are consonant with the belief that the length of the incubation period depends in part on the virulence of the infection. The means of the epidemics due to infected water are 13.81 ± 0.83, 1938 ± 1.66, and 19.50 ± 0.31, whereas the means for those due to infected food, in which the dose was probably more massive, are 7 ± 0.26 and 9.54 ± 0.39.